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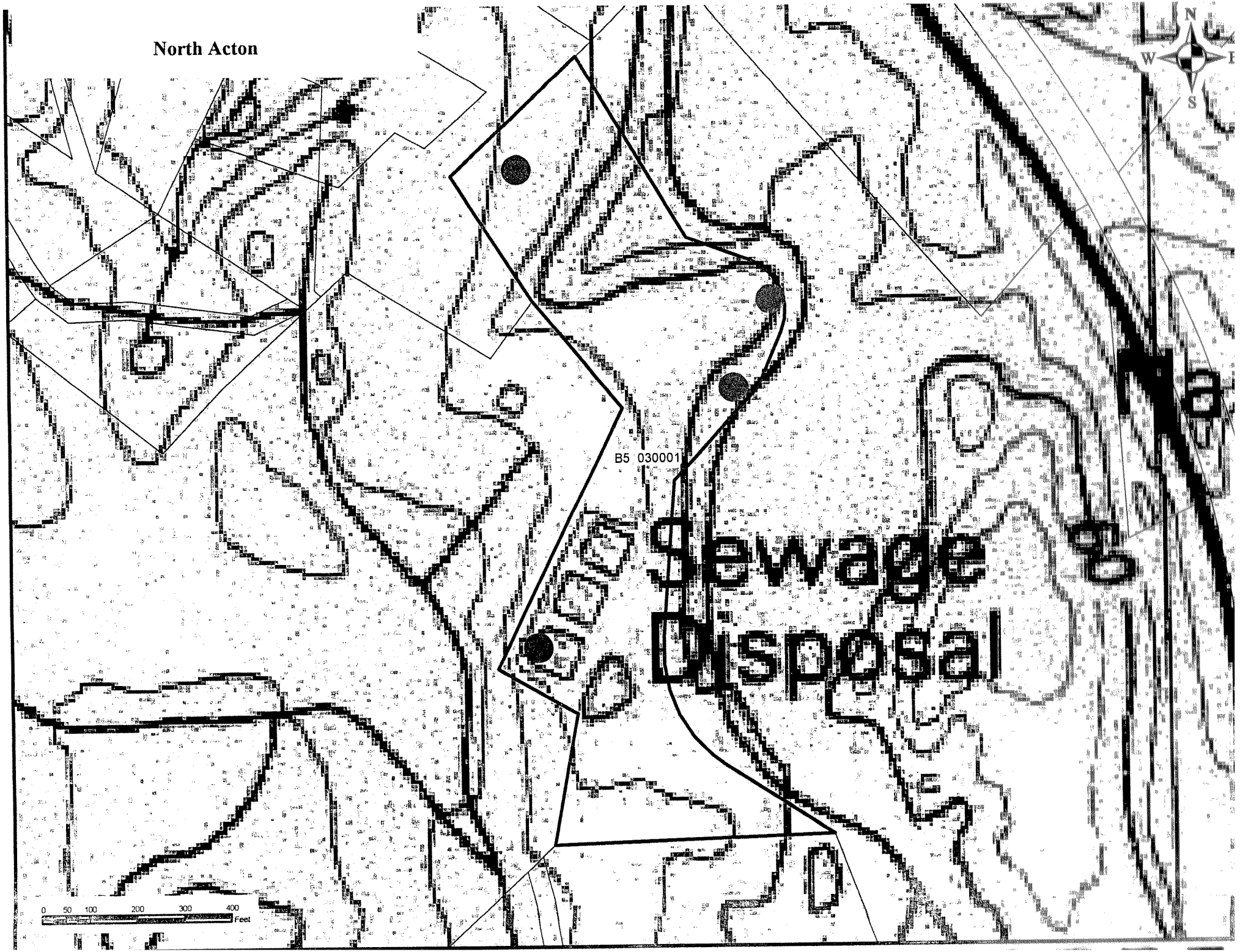
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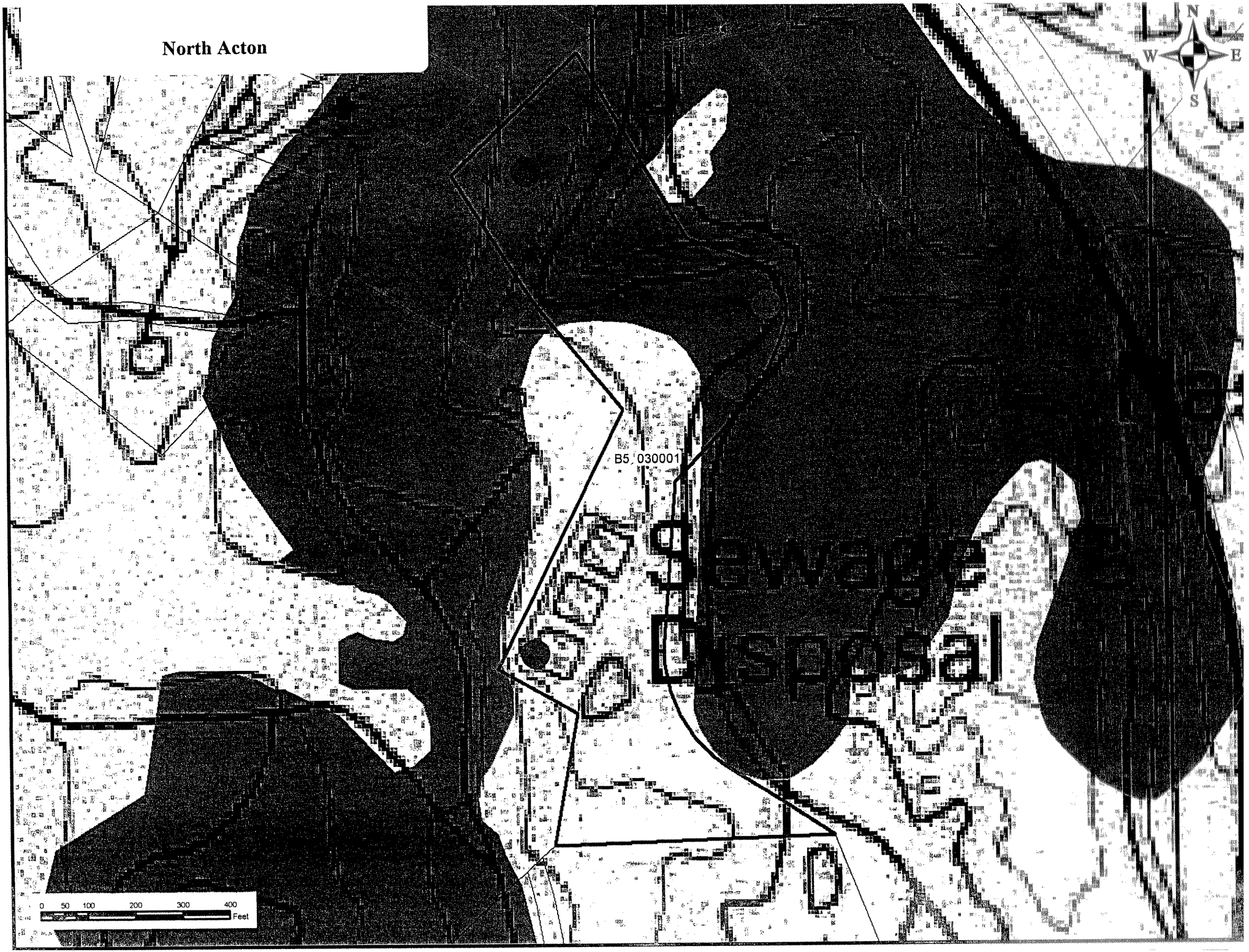
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ACTON CWRMP/EIR

PRELIMINARY HYDROGEOLOGICAL SITE EVALUATION

January 26, 2006

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1. INTRODUCTION

The Town of Acton is conducting Phase 2 of a town-wide Comprehensive Water Resources Management Plan (CWRMP) / Environmental Impact Report (EOEA No. 11781), which is funded through the State Revolving Fund (SRF) program (Loan No. CW 00-40). The Phase 1 CWRMP Report (June 2003) identified areas in need of wastewater solutions other than continued reliance on individual sewage disposal system. The Phase 1 report identified four sites as potential locations for wastewater treatment and disposal locations, and linked these locations to specific Needs Areas. The Town of Acton and Woodard & Curran (W&C) followed the Phase 1 report with correspondence and meetings with DEP to develop a scope for preliminary hydrogeologic site evaluation at the four sites.

In conjunction with this effort, the CWRMP project team has continued to move forward with the Phase 2 CWRMP. This hydrogeologic study is an important component of the Phase 2 efforts that also includes:

- Continued Citizen's Advisory Committee (CAC) involvement with prioritization of Needs Areas and ranking of potential solutions;
- Evaluation of reclaimed water being discharged within the drinking water aquifer by a subcommittee of the CAC, the Indirect Potable Reuse Working Group;
- Evaluation of technical solutions and costs for the Needs Areas;
- Petition and acceptance of new discharge limits at the Acton wastewater treatment facility (WWTF); and
- Public outreach and education through CAC meetings, presentation to the Board of Selectmen, website postings, submittal of a press release, insertion of an informative article with the water and tax billing mailings, and public meetings.

This report presents the findings and conclusions of the preliminary hydrogeologic site evaluation and incorporates DEP comments on the Draft Report originally submitted in November 2005. Related tables and figures are appended to the document text, prior to the appendices, in appropriately labeled dividers. This report will become part of the Phase 2 report and the EIR effort.

1.1 BACKGROUND

As part of the Phase 1 Report, the project team identified potential areas for wastewater treatment and disposal through evaluation of US Geological Survey (USGS) surficial geology maps, National Resource Conservation Service (NRCS) soils maps, data available from the Acton Health Department, and other parcel-specific information from Assessor's data and mapping.

The identification process began with GIS-based selection of potential locations using published USGS and NRCS mapping for depth to groundwater and likely locations of sand and gravel soils (as opposed to fine grained soils with a high percentage of silt or clay). This process identified Areas of Interest (AOIs) for further review. We adjusted the soils type and subsurface condition on a lot-by-lot basis based on Health Department data that was collected and compiled in Phase 1 of the CWRMP.

We targeted parcels of meaningful size, whether vacant, publicly owned, or minimally developed. The criteria identified under Phase 1 also included other considerations such as locations that are not likely to

affect sensitive environmental and human receptors or too close to the wellhead protection area surrounding a municipal well.

We aligned the potential lots with Needs Areas as defined in the Phase 1 report. This matching of Needs with potential disposal locations resulted in prioritizing four sites as potential locations for treated wastewater within Acton. The resulting four locations are shown on Figure 1. They are designated as follows from North to South: North Acton (Quarry Road), Wetherbee Street, Adams Street and High Street.

Once the potential locations were selected, and approved as possible candidates by the Citizens Advisory Committee (CAC), the project team conducted a site walk at each of the locations with DEP personnel to acquaint them with the field conditions and locations of likely explorations.

Following a DEP initial site clearance, a program of exploration was developed and submitted to the DEP on December 17, 2004 for approval as a preliminary exploration phase. The exploration program included the classical test pits and deep hole tests that are normally used for wastewater disposal sites and a number of test borings with soil samples and borehole permeability tests. DEP personnel accompanied the project team for a portion of the exploration program.

The objective of the exploration program is to learn as much as possible (in a preliminary phase) about the three principal hydrogeological features of each site which control the application rate for disposal of wastewater. This information is used to guide a selection process in ranking which locations are suitable for further investigation.

The hydrogeological features of any site which control wastewater application rates are:

1) The type of overburden soils at the location - the proportion of preferable coarse grained (sands and gravels) versus fine grained soils (silts or clays);

2) The thickness of these overburden soils (the depth to till or bedrock); and

3) The depth to seasonal high water table which affects the allowable groundwater mounding.

2. FIELD WORK

2.1 PROGRAM BACKGROUND

The program of fieldwork included the following activities:

- Wetherbee
  - Two test borings to refusal (permanent wells)
  - Two test borings to refusal (temporary wells)
  - Five test pits
- North Acton
  - Two test borings (permanent wells)
  - Two test pits
- Adams Street
  - Two test borings
- High Street
  - Rely on existing exploration information developed during initial well field development and subsequent studies related to the W.R. Grace facility.

Fieldwork began on March 21, 2005. A Professional Geologist supervised the work. A Certified Soil Evaluator supervised the test pits and conducted percolation tests with review by DEP staff. The schedule for beginning field work was driven by the need to be complete with all work on the Wetherbee site prior to the beginning of farming on the field, starting with early spring cultivation. In addition there was a desire to complete the work on the field prior to the complete loss of frost in the ground to minimize surface disturbance. Coordination considerations dictated that all of the sites should be explored in a continuous effort with a single mobilization of equipment and personnel.

Well construction details and test pit construction details are included in Table 1 and Table 2 respectively. Appendix A includes the boring logs with well construction information, and Appendix B contains the borehole permeability test data. Appendix C contains the test pit data and the percolation test forms.

2.2 FIELD PROGRAM RESULTS

2.2.1 Wetherbee Street

Test Borings

Soil Exploration Corporation began drilling operations on the March 21, 2005 at the Wetherbee site. The specifics of the depths, well construction, soil sampling and bore hole permeability testing, as well as hydraulic conductivities, for the four Wetherbee borings are listed on Table 1 and Table 3. Figure 2 shows the boring locations.

Boring W-1 was intended to be carried to auger or split spoon refusal in an effort to determine the thickness of granular overburden soils which would be active in transporting wastewater away from a disposal facility. The boring was terminated at 52 feet after penetrating 10 feet of till and thereby confirming the effective bottom of usable aquifer at the top of till.

The subsequent borings, W-2, W-3, and W-4 were completed by March 23, 2005. Borings W-1 and W-2 are located in the middle of the active farming portion of the field and the wells installed in these borings

were installed as temporary wells, without full grouting or guard pipes. It was understood that as farming commenced the farmer would remove the wells. Wells in borings W-3 and W-4 are at the perimeter of the field and are installed as permanent wells with completed grout seals and guard pipes.

Existing USGS Well

There is a USGS index well at the corner of Wetherbee Road and Route 2 shown as USGS MA-ACW-158 on Figure 3. The published information for this well indicates a well drilled to 33.8 feet below ground surface with a 2-foot long well screen set a 33.8 feet. The soils encountered are glacial sands and gravels. Water levels are recorded for this well from 1965 to present. The highest water level over record for that well is 14.98 ft below ground surface.

Test Pits

Figure 3 shows the locations of the Wetherbee site test pits. DEP personnel witnessed the test pits excavation and joined Acton staff's Certified Soils Evaluator in reviewing the soils classifications. Test pits 32105-1 and 32105-2 at the Wetherbee site were dug along the east flank of the parcel where the sand and gravel deposits are the thickest. The test pits were excavated to depths of 17 and 15 feet respectively; neither excavation encountered groundwater. The estimated depth below ground surface to seasonal high groundwater in each pit is 17 feet and 14.59 feet respectively. Soil samples were collected from each pit for laboratory grain size analyses.

Test pits 32105-3 was excavated on the northern side of the Wetherbee parcel to a depth of 10 feet and encountered till at shallow depth with bedrock at the base of the pit. Groundwater was encountered at six feet below ground surface with the estimated seasonal high groundwater at one foot below ground surface.

Test pit 32105-4 was excavated along the westerly portion of the cleared Wetherbee site and was dug to a depth of 11.5 feet. The pit encountered mostly granular soils with gravely sand material to about 3 feet and finer sands to the bottom of the excavation. Groundwater was standing at 5 feet below surface and seasonal high groundwater is estimated at 3 feet below surface.

Test pits 32105-5 and 32105-6 were excavated along the southern boundary of the cleared Wetherbee site near Route 2. Both excavations encountered granular soils, grading more gravely with depth. The excavations were taken to nine and 13 feet below ground surface respectively. Groundwater was observed at 8.5 feet and 13 feet below surface respectively with estimated seasonal high groundwater at 5.5 and 13 feet below surface respectively.

Soil samples were collected from test pits 32105-1, 2, 5, 6. These four test pits offered the most promising soils conditions based on field observations. The soil samples were sent to the laboratory for grain size analyses. Percolation tests were run at three locations: 32105-A at test pit 32105-1, 32105-B at test pit 32105-6, and 32105-C at test pit 32105-5. Percolation rates were less than 2 minutes per inch in the first two test sites and 3 minutes per inch in test site 32105-C.

The soils encountered in the explorations (boring and test pits) at the Wetherbee Street location are in keeping with published soils information for the nearby USGS well. The new field observations and data from the USGS well suggest that the Wetherbee area consists of glacial sands and gravels, possibly a kame, and are deposited over till. The thickest sands and gravels are near the Wetherbee Street–Route 2 intersection with thinning as the topography and till elevation rises to the northwest.

2.2.2 North Acton

Test Borings

On March 25, drilling moved to the North Acton site. Table 4 displays specifics of the depths, well construction, soil sampling and bore hole permeability testing, as well as hydraulic conductivities. The locations of test borings at the site are shown on Figure 4. Test boring NA-1 encountered brown medium to fine sand with varying amounts of gravel from the surface to 13 feet in depth. From 13 feet to refusal, on assumed bedrock at 23 feet, the boring encountered medium to coarse sand with varying amounts of gravel. Groundwater was encountered at 19.3 feet. A field permeability test was run at 22 feet, and a well was set at 23 feet.

Boring NA-2 was begun and completed on March 25, 2005. The boring encountered fine to medium sand with varying amounts of gravel and some cobbles. The boring met auger refusal in bedrock at 15.5 feet, but did not encounter groundwater; no well was installed.

Test Pits

Three deep hole test pits were dug at the North Acton location as shown on Figure 5. This location is also referred to as the "end of Quarry Road". Percolation tests were not run at this location, nor were soil samples collected for grain size analyses. DEP personnel witnessed the test pits excavation and joined Acton staff in reviewing the soils classifications.

Test pit 32305-1 was dug at the northeasterly extent of the cleared area of the site. The pit was excavated to a depth of 11 feet. It encountered granular soils derived from outwash with significant quantities of gravel and cobbles. No groundwater was observed and the seasonal high groundwater depth is estimated to be 11 feet.

Test pit 32305-2 was also excavated at the northerly end of the cleared portion of the site. The test pit was excavated to a depth of 8 feet at bedrock refusal. The deep hole encountered 8 feet of granular material derived from outwash with significant amounts of gravel, cobbles, and boulders. The excavation did not encounter groundwater. The estimated depth to seasonal high groundwater is 8 feet.

Test pit 32305-3 is located approximately 50 feet into the tree line at the north end of the Quarry Road location. The test pit was taken through 7 feet of granular material derived from outwash with lesser proportions of gravel and cobbles than in the other pits at North Acton. No bedrock refusal was encountered, but groundwater was observed at a standing depth of 5 feet with estimated seasonal high groundwater depth at 5 feet.

2.2.3 Adams Street

On March 23, 2005, the drilling crew conducted test borings on the Adams Street site at the locations shown on Figure 6. Table 5 displays specifics of the depths, well construction, soil sampling and bore hole permeability testing, as well as hydraulic conductivities. Work began with drilling on test boring A-1. This boring encountered a layer of brown, moderately dense sand, gravel and silt which may be till from 2 to 8 feet in depth followed by 10 feet of fine to medium sand, which was underlain by gray coarse to fine sandy silt and gravel for a depth of 22 feet to 47 feet where the boring was stopped. The conclusion is that the gray till at 22 feet depth constitutes the bottom of the overburden soils which could transmit wastewater off the site. No groundwater was encountered, except for possible perched water at the top of till at about 24 feet. No well was installed.

Boring A-2 penetrated brown medium to fine grained sands and gravels to a depth of forty feet. Groundwater was encountered at about 15 feet. A falling head borehole permeability test was run and a well was installed at 31 feet. The principal goal for this boring was to establish a true water table depth/elevation near the documented vernal pool to understand if the water level in the pool is isolated from the general local groundwater depth. In that case the pool water level and its vernal nature would be largely unaffected by the disposal of wastewater in the area. DEP has expressed other concerns related to impacting the shallow groundwater at the Maynard WWTF.

A subsequent site survey indicated that groundwater elevation in the vernal pool is less than a foot different from the elevations of groundwater in a nearby boring. This suggests that any mounding in local groundwater elevation will raise the water elevation in the pool, possibly interfering with its habitat function. Survey and vernal pool information are provided in Appendix D.

2.2.4 High Street

This preliminary evaluation of the High Street site is based on existing subsurface information developed over the years of exploration for water supply and investigations relevant to the W.R. Grace facility. These available sources of information came from reports by Dufresne-Henry for water supply investigations and from GeoTrans reports on the contamination investigations. Appendix E includes the Assabet well pumping tests from 2000 and 2004 and available site feature plans and cross section from GeoTrans. Table 6 provides a summary of useful data, including estimated hydraulic conductivity from previous studies.

Of critical consideration at the High Street location is a concern for the travel time between any treated wastewater dispersal location and the withdrawal points for the water supplies. At the present time, DEP requires a minimum groundwater travel time of two years between the location of treated wastewater dispersal and any groundwater supply well. This minimum travel time is under review and may be reduced to one year.

The available hydrogeological information was used to estimate groundwater velocities at various locations on the site. Based on these estimates, a location was selected with a possible travel time distance of one year or greater. This area is approximately 1,000 feet from the two Assabet wells. Figure 7 shows the location of the potential dispersal site which may likely be one year or more in travel time distant from the wells Assabet #1 and Assabet #2.

If it is decided to continue evaluation of the High Street site, extensive effort will have to be made to confirm groundwater travel times in the area under various pumping scenarios for the Assabet wells.

3. DATA REDUCTION

Most of the results of the data reduction (also specifics of the field exploration) are complied on Table 1 and Table 2, titled Summary - Well Construction Details and Summary - Test Pit Construction Details, respectively. These two tables can be considered as summary tables of all of the information gathered from new field exploration or collected from published sources during this preliminary site evaluation.

Numerical data were generated at several points in the field exploration phase. Soil samples were collected at selected borings and test pits. These samples were sent to a soils laboratory for washed sieve grain size analyses with the intent to use the grain size data for estimating hydraulic conductivity of the soils. The results of the grain size analyses, in the form of grain size distribution plots, are presented in Appendix F.

The data from the grain size distribution plots was used for estimates of hydraulic conductivity (K) in classical estimating formulas by Hazen and by Kozeny-Carmen. Estimates of conductivity from soil grain size distributions are presented for boring samples and test pit samples on Table 7, which presents the results of the grain size K estimates listed by boring or test pit location and depth of sample.

Additional numerical data was generated during the test boring installations. Bore hole permeability tests were run by the falling head method. Field data sheets from these tests are presented in Appendix B. The data from these tests were analyzed for hydraulic conductivity (K) using a program for a computer-based solution of the Hvorsleve slug/bail test equations. The curve matching results from these analyses are presented in Appendix G in units of cm/sec and ft /day, and the numerical results are presented in table format and organized by site on Tables 3 through 6.

4. MOUNDING SIMULATIONS

As stated in the introduction to this report, the objective of exploration for this preliminary evaluation is to understand as much as possible, at a preliminary phase, about the three factors which control suitability of a site for treated wastewater dispersal. Those three factors are:

1) Types of soils – coarse versus fine grained, and the resulting hydraulic conductivity;

2) The thickness of the conductive soils which can function to conduct groundwater; and

3) The seasonal high groundwater depth that limits the available height for mounding groundwater beneath a dispersal facility.

The numerical values for each of these three factors are then applied to a computer model to produce a reasonable simulation of the groundwater flow system at each location. Then the model is used to simulate varying amounts of water applied to the flow system. The resulting groundwater mound at each application rate is noted. At a preliminary phase such as this, most of the three groundwater flow system factors are only know within ranges, but not with great certainty. Thus reasonable ranges of values for these factors are applied to the models, which result in ranges of groundwater mound heights.

Those sites that appear to be highly constrained by mounding (or other factors now known about the locations) are eliminated from further consideration.

Mounding simulations for this study were completed using the well-accepted groundwater model developed by MacDonald and Harbaugh for the USGS in 1988.

A groundwater flow regime is set up within the model with the appropriate features of conductivity, thickness of conductive material, and seasonal high water table. Test runs of the model flow field are made with various application rates of water to the system to determine the height of the groundwater mound that develops in a steady state condition representing long-term application of treated wastewater.

The estimated and tested quantifications of field geological conditions at each location are considered, and the seemingly best portions of each site are selected for simulated wastewater loading with the model. The selected areas for simulated loading in the computer models correspond to the areas delineated on the Borings Locations figures:

- Figure 2: Wetherbee Site
- Figure 4 North Acton Site
- Figure 6: Adams Street Site
- Figure 7: High Street – Proposed Dispersal Area

Figure 8 through Figure 11 represent the model mounding results for selected wastewater application rates.

Tables 8 through Table 11 present the various combinations of hydrogeological factors and model mounding results for each of the four Acton locations.

4.1 WETHERBEE STREET

The mounding analysis is shown in Figure 8. The Wetherbee Street site has approximately 11 acres available for a disposal field. From Table 3, groundwater is approximately 14 feet below ground surface in the area of the proposed disposal field.

From Table 8, the preliminary analysis shows that a groundwater mound of almost 8 feet would result from an application of approximately 1.5 gpd per square feet. The distance from ground surface to the mound would be about 6 feet under this scenario.

Table 8: Wetherbee Site – Summary of Model Mounding Results

application rate gpd/ft^2		application total (gpd)		mound in ft above static GW
0.5		245,381		2.3
1.0		490,762		5.2
1.5		736,181		7.8

Note: 490,800 sq ft facility = approximately 11 acres
Maximum loading for subsurface methods by regulations is 3 gpd/sqft
K = 128 ft/day, which is average from testing at Wetherbee site

A 1.5 gpd per square foot application rate gives a capacity of approximately 736,000 gpd over 11 acres. At this point the groundwater mounding approaches the limit of regulatory separation (6 feet). Since the subsurface disposal system would require a reserve area, the actual maximum application area is 5.5 acres, creating a capacity of approximately 375,000 gpd at the same loading rate. We did not re-model for this application since we are looking for the limiting factors.

4.2 NORTH ACTON

The North Acton site mounding analysis is shown in Figure 9 and Table 9. According to Table 4, the groundwater elevation ranges from approximately 5 feet to approximately 19 feet.

Table 9: North Acton Site – Summary of Model Mounding Results

application rate gpd/ft^2		estimated K value ft/day		application total (gpd)		mound in ft above static GW
0.5		75.0		48,119		5.4
0.5		150.0		48,119		3.1
1.0		75.0		96,237		8.8
1.0		150.0		96,237		6.7

Note: 96,250 sq ft facility = approximately 2.2 acres

The preliminary analysis shows groundwater mounding ranging from 3.1 feet to 8.8 feet. The test pits exhibited groundwater elevations too shallow for a disposal field, with cobbles and boulders throughout the excavations. The groundwater elevation in the two borings was much further below the ground surface than the test pits. Boring/Well NA-1, however, is located in a heavily used and altered area, and further investigation would be required prior to conducting more precise modeling.

Test boring NA-2, in the northeast corner of the parcel, has bedrock at 15.5 feet below ground surface, with no groundwater, but the slope and bedrock in the area would warrant further investigation prior to a more refined analysis. As shown in Figure 4, the northeast portion of the parcel is mostly undisturbed, and therefore the most likely location for a potential disposal area.

4.3 ADAMS STREET

The Adams Street site mounding analysis is shown in Figure 10 and Table 10. Figure 6 shows the proposed disposal field location. The field is divided into two sections because of topography and to avoid a vernal pool located on the parcel.

Table 10: Adams Street Site – Summary of Model Mounding Results

application rate gpd/ft^2		estimated K value ft/day		application total (gpd)		mound in ft above static GW
0.5		30.0		83,746		4.8
0.5		50.0		83,746		3.0
1.0		30.0		167,484		8.8
1.0		50.0		167,484		5.6
1.5		50.0		251,238		8.0

Note: 167,500 sq ft facility = approximately 3.8 acres

DEP allows a discharge of 2.0 gpd/square foot, 3.0 gpd/square foot with advanced testing such as a loading test, if open sand beds are used. This is contingent on the site conditions and other testing at the DEP's discretion. According to Table 5, the depth of groundwater ranges from approximately 15 feet below the ground surface between the sections, to over 24 feet at the eastern portion of the parcel. The mounding analysis shows that groundwater mounding should not cause interference with a disposal facility, but is approaching the limiting factor of 7-feet below the surface at the 1.5 gpd/square foot rate.

The Adams Street site may be the most uncertain because of major terrain variations, potential for breakout on the slope in the eastern section, possible perched water table hydraulically connected to the vernal pool in the western section, and potential impact on the groundwater elevation at the nearby Maynard WWTF. The mounding analysis showed a rise in groundwater elevation in this area, which could possibly interfere with the vernal pool's function. Given these uncertainties, we used a conservative approach, stopping the loading analysis at 1.5 gpd per square foot. Further analysis should be conducted before proceeding with site investigations in this area.

4.4 HIGH STREET

Figure 11 displays the results of the High Street site mounding analysis. Table 11 presents the numerical hydrogeological factors and mounding analysis results.

The one-year travel time appears to be approximately 1,000 feet up gradient from the Assabet #1 and Assabet #2 wells. Figure 7 displays the area selected for the proposed dispersal facility location.

Table 11: High Street Site – Summary of Model Mounding Results

application rate gpd/ft^2		estimated K value ft/day		application total (gpd)		mound in ft above static GW
0.5		130.0		83,192		0.4
1.0		130.0		166,385		0.7
1.5		130.0		249,592		1.1
2.0		130.0		332,785		1.5
2.5		130.0		415,992		1.8
3.0		130.0		499,200		2.2

The dispersal of reclaimed water on land and the subsequent groundwater mound will change local groundwater gradient. This condition was not addressed in this preliminary evaluation of disposal sites. If the High Street site is selected for further study this aspect will have to be addressed with additional exploration and transport modeling.

5. CONCLUSIONS

A comparison of Tables 8 through 11 indicates that the Wetherbee site has the greatest capacity for treated wastewater application with the least mound creation. Geologically this is the preferred location. The other three sites do not exhibit the potential capacity without other technical or hydrologic hurdles.

The North Acton site is able to accept loading rates up to one gallon per square foot per day, but it appears to be a small site with limited total capacity. The ground surface on the majority of the site is heavily disturbed and much of the native material has been removed. The CAC did not rank the offsite treatment facility and disposal field at this location as the preferred/priority solution. Therefore, we do not recommend further study of this area.

Loading at the Adams Street location is problematic because of potential disturbance to the vernal pool, possible slope breakout toward the river and potential influence on the groundwater level at the Maynard wastewater treatment facility site. The eastern portion of the proposed area may hold promise, but DEP recently agreed to permit an additional 49,000 gpd discharge capacity to the WWTF's rapid infiltration basins. Further study of this potential dispersal area, as part of this CWRMP/EIR, is not warranted to serve the priority needs parcels. The Town owns the parcel and can hold it available if the CWRMP/EIR identifies additional needs that justify further exploration.

Discharge of treated wastewater at the High Street location will require extensive exploration and groundwater flow testing to confirm that any possible dispersal location is more than one year's travel time from the municipal wells. The parcel does not support a dispersal location with a two year's travel time from the municipal wells. We do not recommend further study at this site under this CWRMP/EIR.

The most promising location, hydrogeologically, is the Wetherbee Street site, which is aligned with the East Acton Needs Areas (Area 3 and Area 4) as an offsite alternative. However, research into the availability of the parcel has uncovered a deeded legislative conservation restriction. The town is pursuing further information through its Town Counsel. The CWRMP Phase 2 report will provide updates on this issue, and the EIR process will further refine the alternatives evaluation.

6. RECOMMENDATIONS

The potential disposal areas have drawbacks that limit the Town's options. But, each Needs Area associated with the four dispersal locations has another viable solution in addition to construction of a satellite facility. Therefore, we do not recommend further hydrogeologic study as part of the CWRMP/EIR.

We recommend that the Town clarify the availability of the Wetherbee Street site to determine if this parcel remains a viable alternative for East Acton, in addition to cluster/shared systems and a wastewater management district. Further evaluation of this situation will be discussed in the Phase 2 CWRMP and EIR.